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312. Proposed by J. A. CAPARO, C. E., Notre Dame University, Notre Dame, Ind.

Two roots of the cubic $x^3-px^2+qx-c=0$ are equal. Find their value in terms of p, q, and c.

I. Solution by GEORGE W. HARTWELL, University of Kansas, Lawrence, Kas.; V. M. SPUNAR, M. and E. E., East Pittsburg, Pa.; and G. I. HOPKINS, Instructor in Mathematics and Astronomy, Manchester High School, N. H.

Let m, m, n be the three roots. Then

$$2m+n=p\ldots(1);\quad 2mn+m^2=q\ldots(2);\quad m^2n=c\ldots(3).$$

Solving (1) and (2) for m and n we have,

$$m=\frac{p\pm\sqrt{(p^2-3q)}}{3},\quad n=\frac{p\mp2\sqrt{(p^2-3q)}}{3}.$$

Substituting these values in (3),

$$(2p^2-6q)\left(\frac{p\pm\sqrt{(p^2-3q)}}{3}\right)=pq-9c\ldots(4).\ \text{But}\ \frac{p\pm\sqrt{(p^2-3q)}}{3}=m.$$

Therefore, from (4), $m=\dfrac{pq-9c}{2p^2-6q}$.

II. Solution by G. B. M. ZERR, A. M., Ph. D., Philadelphia, Pa.; J. SCHEFFER, A. M., Hagerstown, Md.; S. LEFSCHETZ, Wilkinsburg, Pa.; and the PROPOSER.

Let $f(x)=x^3-px^2+qx-c=0$, $f'(x)=3x^2-2px+q=0$.

If $f(x)$ has two equal roots, $f'(x)$ contains one, and hence the greatest common divisor of $f(x)$ and $f'(x)$ gives one of the equal roots. Now if

$$(pq-9c)(27c+4p^3-15pq)=4q(3q-p^2)^2,\ \text{or}$$
$$18cpq+p^2q^2-4cp^3-4q^3-27c^2=0,$$

then $2(3q-p^2)x+pq-9c$ is the greatest common divisor of $f(x)$ and $f'(x)$.

Therefore, $x=(9c-pq)/[2(3q-p^2)]$ is one of the equal roots.

GEOMETRY.

339. Proposed by G. E. BROCKWAY, Boston, Mass.

Of all triangles that can be inscribed in a given triangle, that formed by joining the feet of the altitudes has the minimum perimeter. Prove by means of the straight line and circle.